Artificial Intelligence as Support for Product Companies Servitization

Jassen Rodrigues da silva*
jassen.rodrigues@ufrgs.br

Alejandro Germán Frank*
ag.frank@ufrgs.br

*Organizational Engineering Group (Núcleo de Engenharia Organizacional – NEO), Department of Industrial Engineering, Universidade Federal do Rio Grande do Sul, Brazil

Abstract

Servitization has been implemented in different sectors, highlighting the growing interest of manufacturing companies in this type of strategy, where they are challenged to rethink their offerings to develop and deliver Product-Service Systems. In addition, the literature has devoted special attention to the process of digital transformation of industries and companies, especially in the context of the so-called Industry 4.0, a process that has been supported by the implementation of basic technologies such as artificial intelligence (AI). However, although the potential for applying AI in services has been demonstrated, there are still no studies that guide product companies in the use of AI for servitization. Thus, this study carries out a systematic literature review to identify and analyze the existing literature, thus obtaining a broader view of the topic. The results showed that AI has been applied in several back and front-office solutions, but predominantly in support activities. Also, challenges were identified for the implementation of the technology, such as the need for base technologies and the understanding of the requirements for the new type of contact that AI provides. Still, it was possible to identify that the literature approaches the solutions in a very generic way, not deepening the type of AI applied nor how the implementation is done, being very superficial from the point of view of the implementation of AI solutions in servitization.

Keywords
Servitization, Digital servitization, Artificial intelligence, Systematic literature review

1. Introduction

Servitization, widely recognized as a value creation process, adding services to products (Baines and Lightfoot, 2013), has been implemented in different sectors, highlighting the growing interest of manufacturing companies in this type of strategy (Bustinza et al. 2015; Paslauski et al. 2016). Through this strategy, companies benefit in many ways such as revenue growth, strengthening the supplier-customer relationship, greater customer loyalty, differentiation and robust market defense against the competition, and building new revenue streams (Grubic 2018). These companies are challenged to rethink their offerings, seeking to develop and deliver Product-Service Systems (PSS), and in this sense, one of the growing applications of digital technologies is the delivery of services linked to smart products (Marcon et al. 2019; Porter and Heppelmann 2015).

In parallel, the literature has devoted special attention to the process of digital transformation (digitalization) of industries and companies, especially within the context of the so-called Industry 4.0 (Dalenogare et al. 2018). This transformation process has been supported by the implementation of four core technologies: internet of things (IoT), which provides connectivity; cloud computing, which enables ubiquity; big data, to create massive data warehouses; and artificial intelligence (AI) to provide advanced data analysis (Frank, et al. 2019). Digitization is seen as a source of competitiveness due to its potential for value creation and revenue generation, where suppliers and customers tend to shift from a product-centric model to a service-oriented one (Frank et al. 2019), the use of these digital technologies to support the servitization of product companies is called digital servitization (Kohtamäki et al. 2019). In general, these technologies facilitate the interaction of product companies with their customers, who often have complex and heterogeneous demands, and accelerate data-sharing throughout the supply chain (Wei et al. 2017). Thus, the

development of servitization strategies by companies naturally encourages the adoption of digital technologies, because such a strategy demands more information and greater control over the use of products. In this way, digitization becomes a driver of servitization (Martín-Peña et al. 2019). Consequently, there is great potential to be explored in the application of digital servitization by manufacturing companies (Paiola and Gebauer 2020).

In this context, AI has supported manufacturing companies in many ways. On machines, advanced analytical tools can analyze data collected from sensors to monitor and predict failures, automatically identify product nonconformities, as well as complement systems such as ERP, with demand forecasting and order fulfillment (Frank et al. 2019). AI also allows plant managers to perform fast and efficient analysis of data sets to support real-time decision-making applied to predictive maintenance and production planning (Cohen et al. 2019). However, the potential of AI is not restricted to one-off applications within factories. The evolution of digital technologies has generated a more connected economy, and, with the consequent increase in data wealth, new opportunities present themselves for manufacturing companies seeking competitive advantages supported by AI (Ayala et al. 2020; Frank et al. 2019; Gebauer et al. 2020).

For example, AI manifested by machines displaying aspects of human intelligence is increasingly used in services, such as virtual bots turning customer service into self-service, big data applications, and social robots (Huang and Rust 2020). Thus, AI enables manufacturing companies to reduce the costs and risks associated with servitization, enabling the innovation of their business models, migrating from basic monitoring and control applications to solutions with more advanced functionality for interacting with customers (Kohtamäki et al. al. 2019). However, although the potential for the application of AI in services is evident, there are still no studies that guide product companies in the use of AI for servitization (Martín-Peña et al. 2019). Therefore, this article seeks to answer the following research question: *how can AI support the servitization of product companies*?

To answer this question, this study carries out a systematic literature review (RSL) to analyze the contributions of technology in the servitization process, given that this is a growing but still incipient area. Thus, we seek to synthesize the results, thus obtaining a broader view of the topic (Van Dinter et al. 2021).

Our results demonstrate that AI has been applied in several back and front-office solutions, but with a predominance of solutions in support activities. Also, it was possible to identify that the literature approaches the solutions in a very generic way, not deepening the type of AI applied nor how the implementation is done, being very superficial from the point of view of the implementation of AI solutions in servitization.

1.1 Objectives

The main objective of this article is to understand how AI can support servitization of product companies.
This general objective is based on three specific objectives:
1) Identify in what kind of solution AI has been applied in servitization.
2) Identify how the literature has approached servitization with AI.
3) Mapping the challenges for companies looking to servitize their business with AI

2. Theoretical Background

2.1 Digital Servitization and the AI Contribution

Digital servitization can be defined as a phenomenon under which manufacturing companies develop new business opportunities by combining products and services into digitization-enabled product-service systems (Simonsson and Agarwal 2021). In this sense, recently, a growing stream of research has started to focus on how digital technologies enable or support the development of services, giving rise to digital servitization as a specific research stream (Paiola et al. 2021). Digital servitization describes the convergence between servitization and digitization (Gebauer et al. 2021), which can be defined as the process of developing new services or improving existing ones through digital technologies (Paschou et al. 2020). Exploring new technologies, companies are increasingly improving their service offerings (Cimini et al. 2021), moving from offering pure products or with complementary services to intelligent product-service systems (Kohtamäki et al. 2020). Digital servitization is completely changing the way services are delivered, facilitating new sophisticated service offerings and enabling new servitized business models (Cimini et al. 2021), where companies are increasingly competing with solutions that involve innovations such as, for example, AI (Gebauer et al. 2021), which can fully empower or transform service capabilities (Paschou et al. 2020).

Today, AI, which can be defined as the ability of a system to interpret data, learn from that data, and use these learnings to achieve specific goals and tasks (Kaplan and Haenlein 2019), is present in different sectors of the economy and widespread. in the business models of several companies (Dwivedi 2021), where they use AI, along with other technologies, to increase the efficiency of their processes, both in the manufacture of products and in the provision of services, modifying the structure of their business models. business (Paschou et al. 2020). In this sense, AI has shown a great capacity to provide services and carry out various activities (Huang and Rust 2018) and also for the development of the industry (Lee et al. 2018), demonstrating an enormous potential for contributing to the servitization of product companies (Dwivedi, 2021), being used both in back-office activities, which is any process necessary for the execution of the service and in front-office activities, which can be considered the interface with which customers interact (Lugnet et al. 2020).

However, even with the presence of AI in several services, it is still not clear in the literature what its potential for servitization is (Martín-Peña et al. 2019), lacking an organization of works on the subject. In this way, it is essential to deepen the knowledge about how AI is being applied in the servitization of product companies, as well as which areas of research are addressing this process, for a broader understanding of the topic. However, this analysis should not be carried out only under the lens of technology, but in a socio-technical approach (Beier et al. 2020), given that the context of Industry 4.0 requires a socio-technical evolution of the human role in production systems (Frank et al. 2019) thus providing better results (Baxter and Sommerville 2011).

The sociotechnical approach involves the Social, Technology, Organization, and Environment dimensions (Carayon et al. 2014; Baxter and Sommerville 2011). The social dimension encompasses the relationship between people and technology, and how this impacts its implementation (Li et al. 2020). The technology dimension is related to the structure that the company needs and has, including the characteristics of the technology, compatibility, and interoperability with the current system and how this can impact the adoption of the new technology (Masood and Egger 2019). The organizational dimension is related to the company's characteristics and resources, such as support for new technologies, available resources, and the support of the company's culture regarding this new technology (Masood and Egger 2019; Baxter and Sommerville 2011). The environmental dimension expands interactions with external actors since they are part of an ecosystem of their industry with, for example, competitors, partners, and regulations, which can affect the implementation of the technology (Masood and Egger 2019).

3. Method

To identify different ways of using AI to support the servitization of product companies, an RSL was carried out. This type of review is based on a protocol that describes the rationale and predefined eligibility criteria (Moher et al. 2015). Thus, the development of this RSL was based on the PRISMA method (Moher et al. 2015), which consists of a checklist and a four-phase flowchart (identification; screening; eligibility, and included), which aims to facilitate the preparation and reporting of a robust protocol for the systematic review. After the development of the RSL, the results are presented, which were divided into ways of applying AI in the back and front-office, its impact on business models, and the challenges for its application, according to the socio-technical dimensions.

3.1 Research Question Formulation

The first step in the methodology of an RSL is the definition of the research question which, as it is a fundamental step in the study, must be clear, as it will provide the focus and direction of the research (Rasimah et al. 2015). Thus, based on a gap identified in the literature, the following research question was defined: How can AI support the servitization of product companies?

3.2 Articles Location

At this stage, the objective is to locate studies that are aligned with the research question, and that helps in its answer. For this, the Scopus and Web of Science databases were chosen, as they are the most relevant databases on the subject. Also, it was defined that the search string should be present in the title, abstract, or keywords of the articles. For the searches performed, keywords were selected according to those used in the literature in studies on servitization (Tukker 2004; Baines and Lightfoot 2014), and how AI has been used in the context of digitization (Kohtamäki et al. 2019), digitization and digital transformation (Frank et al. 2019), these words were included in the AI aspect, as well as artificial intelligence itself (Kaplan and Haenlein 2019; Huang and Rust 2018) and machine learning, which is one of the most used categories in the scope of digital servitization (Cimini et al. 2021; Paschou et al. 2020) seeking articles

that addressed the themes together. Thus, according to the keywords, the search string was defined, as shown in Table 1.

Table 1: search terms

Keywords	***string***
Servitization	"servitization" OR "PSS" OR "product-service system" OR "product service system" OR "service innovation"
Artificial Intelligence	"Artificial intelligence" OR "machine learning" OR "digital transformation" OR "digitization" OR "digitalization"

3.3 Selection and Evaluation

In the first step, identification, filters were defined for the search performed, to find articles aligned with the research question. Only articles published from 2011 to 2020 were analyzed since in 2011 the term Industry 4.0 was introduced (Pfeiffer 2017) where the literature began to devote attention to the process of digitization of industries and companies (Dalenogare et al. 2018) with the support of AI and other technologies (Frank et al. 2019). Then, the document type filter was applied, looking for only peer-reviewed scientific articles, and also the language filter, where the articles should be written in English, reaching a total of 327 articles on the two bases.

Afterward, in the screening stage, the articles from the two bases were analyzed in the search for duplicate results where, with the help of the Mendeley software, 88 articles were found and excluded. Also, filters were used to select articles published in the areas of Business, Management, Operations Research Management Science, Engineering Industrial e Engineering Manufacturing in the Web of Science database, and in the areas of Business, Management and Account e Engineering in the Scopus database, since they are areas related to the intentions of the study, where 84 articles were excluded, as they were in journals from other areas, reaching a total of 151 articles.

Then, in the eligibility stage, an analysis of titles, keywords, and abstracts was performed to confirm the alignment of the articles to the research question, selecting only those that investigated the adoption of AI to support the operation of services in product companies, and not articles those present technical questions about technology or service offerings in companies originally in the service sector. At this stage, 81 articles were excluded, leaving 70 articles to be read in full. Subsequently, after reading the articles, 58 of them were excluded because they did not fit the purpose of the research, such as, for example, articles that did not describe in which solution the AI was being used. Thus, there were a total of 12 articles to be analyzed in the study, as shown in Figure 1.

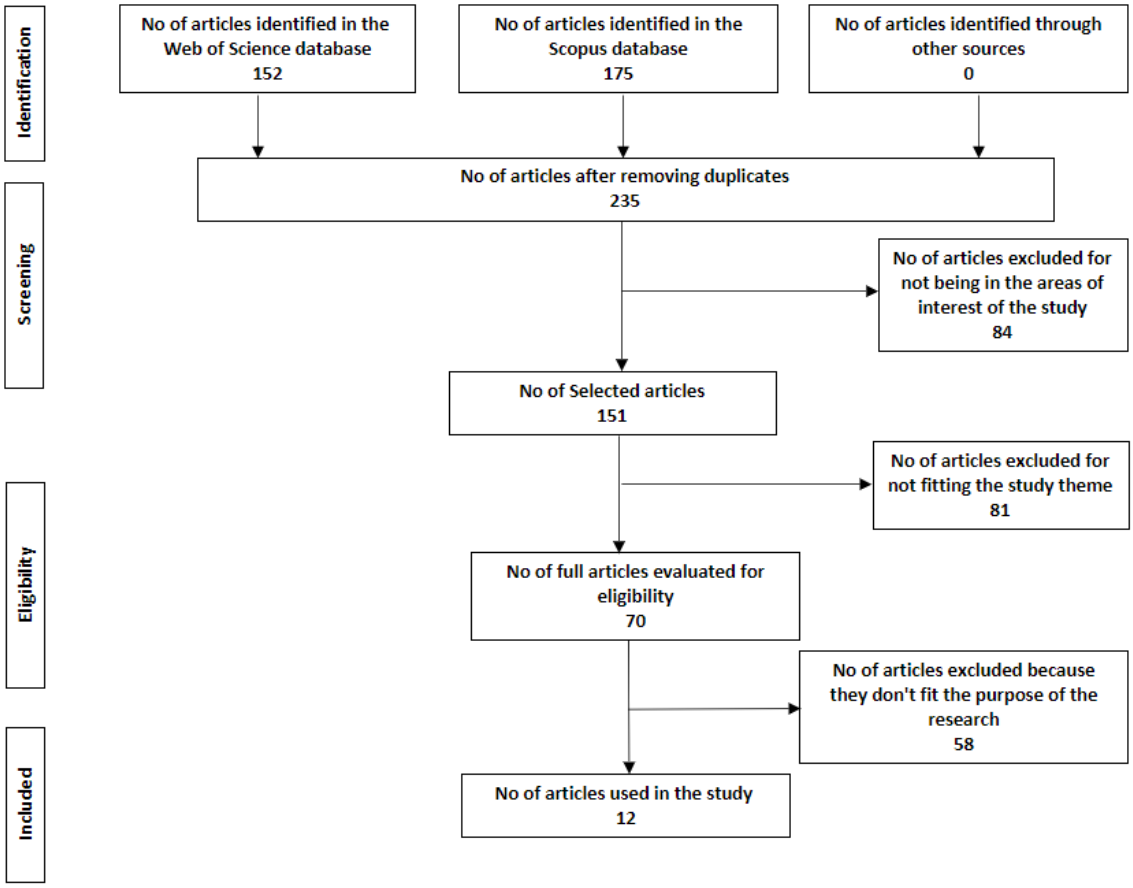

Figure 1: flowchart for the selection of revised literature based on the PRISMA method

3.4 Descriptive Analysis

The descriptive analysis of the articles considered relevant to the answer to the research question was carried out about the year of publication, theme, journal, and industrial sector, to identify trends in the literature and is presented in Table 2.

Table 2: descriptive analysis of studies

Author	Year	Theme	Journal	Sector
Lerch e Gotsch	2015	AI applied in the analysis and feedback of processes to offer predictive maintenance in PSS	Research-Technology Management	Diverse
Cenamor et al.	2017	AI to analyze data and support customer operations	International Journal of Production Economics	Diverse
Lenka et al.	2017	AI for data analysis in the digitalization of companies, enabling the offer of new services	Psychology & Marketing	Diverse
Pagoropoulos et al.	2017	AI to support decision-making in pricing services	Journal of Cleaner Production	Maritime
Chowdhery and Bertoni	2018	AI to support decision-making in pricing services	International Federation of Automatic Control	Industrial machinery and equipment
Jantunen et al.	2018	AI for the shift from traditional to predictive maintenance offering	Journal of Systems and Control Engineering	Industrial machinery and equipment
Heinis et al.	2018	AI to support decision-making in pricing services	Research-Technology Management	Diverse
Alegeh et al.	2019	AI for machinery company servitization with predictive maintenance offering	International Journal of Mechanical Engineering and Robotics Research	Industrial machinery and equipment
Frank et al.	2019	AI in smart products to offer services	International Journal of Production Economics	Diverse
Qvist-Sorensen	2020	AI applied to internal and external processes for the provision of services	Central European Business Review	Industrial machinery and equipment
Björkdahl	2020	Application of AI in digitizing and enabling new services	California Management Review	Diverse
Paiola and Gebauer	2020	AI for machinery company servitization with predictive maintenance offering	Industrial Marketing Management	Industrial machinery and equipment

Observing the publications by period, presented in Table 2, it is possible to notice that studies that address the use of AI to offer services in manufacturing companies are relatively new, with the first studies identified from 2015. Also, it is possible to perceive that the largest number of articles is published in the International Journal of Production Economics (2) and Research-Technology Management (2). The International Journal of Production Economics welcomes studies in the area of manufacturing and production engineering, logistics, production economics, and production strategy. These articles address AI as an enabler for the servitization of companies. Research-Technology Management focuses on articles that connect theory to practice in innovation management, and its articles address AI as a technology to support the general innovation activity of companies. The rest of the publications are divided into journals in areas such as management, technology, and marketing.

4. Results and Discussion

4.1 AI impact on Business Models

In addition to facilitating the continuous optimization of internal processes, AI is being considered an enabling and fundamental technology for the development of a range of new business and earning opportunities for companies with servitized offerings (Qvist-Sorensen 2020). Consequently, the complexity of the model increases, since, in addition to focusing on the quality of the manufacturing processes of the products, these companies have to guarantee the quality of the new services, with differentiated characteristics and requirements, made possible by this new technology.

AI, along with other digital technologies, is enabling improved usage metrics where, for example, based on data collected through sensors on equipment, an in-depth analysis of component depreciation, which is added to pay-per-view pricing models, is possible. use, very common in advanced services, thus allowing these models to be applied to a wider range of products, helping the servitization of manufacturing companies (Heinis et al. 2018; Qvist-Sorensen 2020). Also, in the maritime industry, AI has been applied for data analysis, helping to estimate costs and improving the responsiveness of companies to opportunities (Pagoropoulos et al. 2017). In this way, AI is enabling new business models, where companies that had their models based on selling products, move to servitized models.

When applied to the analysis of data captured by sensors on different parts, AI allows manufacturers to identify the moment when the equipment will break, making it possible to offer predictive maintenance to its customers, moving to a performance-based model. It also allows the change to a fee-for-service model, when used for the analysis of pilot behavior data, enabling the offer of training programs. AI is also enabling service subscription models, for example in production optimization offerings, where it analyzes production data and suggests or performs activities for optimization (Qvist-Sorensen 2020) and availability agreements, where industrial equipment companies use AI to analyze equipment usage data (Cenamor et al. 2017; Lenka et al. 2017). In this way, AI is enabling or making viable these business models, which were previously difficult to implement, mainly due to its analytical capacity.

4.2 Types of AI Application in Servitization

As pointed out in the theoretical framework of the study, AI has been applied in both back-office and front-office solutions. Thus, in the analysis of the articles, it was possible to identify different applications in each of the areas, as shown in Table 3, which brings the applications and the respective authors, which will be discussed below.

Table 3: AI applications in the back and front-office

	Application	Authors
Back-office	Predictive maintenance	Alegeh et al. 2019; Björkdahl, 2020; Cenamor et al. 2017; Jantunen et al. 2018; Lenka et al. 2017; Qvist-Sorensen, 2020; Lerch and Gotsch, 2015; Paiola and Gebauer, 2020
	Service pricing	Chowdhery and Bertoni, 2018; Heinis et al. 2018; Pagoropoulos et al. 2017
	Simulation of operations	Björkdahl, 2020; Lenka et al. 2017
	Spare parts	Qvist-Sorensen, 2020
	Monitoring and security systems	Qvist-Sorensen, 2020
Front-office	Route optimization	Björkdahl, 2020; Frank et al. 2019
	Smart products	Frank et al. 2019; Lenka et al. 2017
	Assisted steering systems	Qvist-Sorensen, 2020
	Training program	Qvist-Sorensen, 2020

4.2.1 AI in the Back-office

Several authors point out that AI causes a significant increase in the efficiency and quality of processes (Anandakumar and Akshaya 2019; Qvist-Sorensen 2020). In the back-office, AI has been used for several purposes, but the one that stands out the most in the literature is its application in predictive maintenance. Due to its ability to process a large amount of data (Lenka et al. 2017), AI has enabled new condition-based maintenance techniques (Cenamor et al. 2017; Alegeh et al. 2019), where predictive insights enable companies in the market to proactively engage with customers and capitalize on opportunities as they arise (Jantunen et al. 2018), making AI-enhanced predictive maintenance replacing preventive maintenance for good (Björkdahl 2020). An example of this solution is that of ABB, a global leader in energy and automation technologies that, using AI to analyze the data collected by sensors, creates value for its customers through its robots connected to the cloud, which allows maintenance that is sold as a service (Björkdahl 2020). This may be the most common application of AI for servitization, due to the fact that companies continue to keep the product as the main actor in their proposals, without the need to drastically modify it, requiring only the installation of sensors to monitor the process. performance of machines and their components and, later, the use of AI to process the collected data.

Thus, AI has the possibility of new and customized offerings for the possibility, without servitization path, how companies can use AI software to perform simulations and display the results of changing production lines, products, and services, designing industry of customized solutions that align with customer requirements (Lenka et al. 2017; Björkdahl 2020), the better the risks involved in the solutions. Also, with its analysis capacity, it has been allowing different measurements for the pre-coding of products and services, which impact revenues and sometimes change the activities of key companies, as in the case where AI algorithms analyze data. of sensors Embedded in activities, usage measures that start to consider the type of material processed by the equipment and being able to replace or complement the models that only consider the operating time (Heinis et al. 2018).

In addition, AI is also being applied to more basic services within these solutions, such as parts replacement (Qvist-Sorensen 2020), where companies monitor the state and performance of machines and equipment through data

collected by sensors and, with the help of AI for data analysis, they offer replacement parts at the right time, according to the monitoring of their wear. Another application is in systems for monitoring and managing the mobility of people offered by manufacturers of elevators and escalators (Qvist-Sorensen 2020), where they use AI to analyze the data collected from the flow of users and thus offer solutions according to its usage characteristics. In this sense, in addition to the benefits for back-office processes, AI companies can analyze a much greater amount of data and obtain more knowledge of the entire chain, generating several opportunities for new services, even those of direct contact with the customer, as discussed below.

4.2.2 AI in the Front-office

In the front-office, AI can be applied in several ways, as in the case of making traditional manufacturing products smart (Björkdahl 2020; Fettermann et al. 2020). Using AI, products can autonomously optimize and extend their functions to customers, bringing new opportunities for manufacturers and enabling the development of PSS, where manufacturers can offer additional services with the product and even offer the product as a service (Dalenogare et al. 2019; Frank et al. 2019; Björkdahl 2020), as technology is enabling new functions and capabilities related to its monitoring, control, optimization and autonomy (Porter and Heppelmann 2014). Following this strategy of smart products, the manufacturer JBL has added to its speakers Google's AI, Google Assistant, which offers a series of services triggered by voice commands.

In the automotive sector, how companies are connecting their vehicles to the cloud to enable new services (Björkdahl 2020). In this sense, AI has been offering offers such as improved driving performance (Qvist-Sorensen 2020), maintenance assistance, and connectivity of in-vehicle information systems allowing communication with cars (Grieger and Ludwig 2020), where the various infrastructures environmental and operational data to their manufacturers and software receipts, which improve their performance or prevent problems from occurring (Porter and Heppelmann 2015). An example of the possibilities that AI is promoting for companies in the sector is that of Ford, in its micromobility unit, with the manufacture of electric scooters. As with advanced driver assistance systems, this new platform combines cameras, sensors, and AI to create a safer passenger and passenger experience, with real-time monitoring of the environment and aiding the driver in making safer decisions.

In this way, AI is enabling companies to move forward and provide innovative services based on selling directly to customers (Björkdahl 2020) such as the monitoring and training of pilots offered by Rolls Royce, where AI algorithms process the behavior data of pilots, identifying unwanted movements that lead to higher fuel consumption. An example similar to that of the company John Deere, an important manufacturer of agricultural equipment, which uses AI to analyze the data collected from sowing and harvesting and offers its customers the service of production optimization, with recommendations and guidance for the process in real-time (Qvist-Sorensen 2020). AI is also in solutions such as digital platforms with analytical capabilities that enable route optimization (Björkdahl 2020) and efficient deliveries (Frank et al. 2019), where truck manufacturers start to offer services to their customers (Björkdahl 2020). In this way, companies can offer services added to products in more efficient offers, adding value to proposals and allowing greater contact with customers.

Thus, in the front-office, it is possible to see that companies are moving towards services more focused on the emerging needs of customers, based on the information that is being obtained through their products, and not so much on services linked to the products. Thus, they move towards increasingly servitized proposals where they are likely to face challenges, as AI enables completely new business models, both in back-office and front-office activities.

4.3 Challenges for using AI in Servitization

AI brings several possibilities for companies that implement it in their processes, but as with the implementation of any technology, some challenges affect its use and that must be considered by practitioners when deciding to implement it in the servitization of their companies. Thus, the analysis of the challenges presented in the literature was carried out using the perspective of the 4 socioeconomic factors and according to their predominance in the back or front-office (Table 4).

Table 4: challenges for implementing AI in servitization.

Sociotechnical Dimensions	**Challenges**	
	Back-office	**Front-office**
Social	Specific knowledge (Jantunen et al. 2018; Cenamor et al. 2017)	Ability for the new type of contact (Qvist-Sorensen 2020; Lerch and Gotsch 2015)
Technology	Base technology for data collection (Heinis et al. 2018) Appropriate processes (Björkdahl, 2020) Resources for the offering (Lerch and Gotsch 2015)	Adequate platform (Cenamor et al. 2017) Connection capability (Lenka et al. 2017) Technology investment (Jantunen et al. 2018)
Environment	Relationship with suppliers (Lerch and Gotsch 2015) Uncertainties of the external environment (Björkdahl 2020)	Uncertainties of the external environment (Björkdahl 2020)
Organization	Strategic and organizational change (Björkdahl 2020; Qvist-Sorensen 2020)	Strategic and organizational change (Björkdahl 2020; Qvist-Sorensen 2020)

In the social dimension, in the back-office, the highlighted challenge lies in the fact that the implementation of systems with AI supposes a very specific knowledge, which in most companies is not available (Jantunen et al. 2018), causing the need arises for a search for these skills in the market, or development within the organization. In the front-office, AI is changing the way of interaction, both between companies and with their customers (Lerch and Gotsch, 2015) and this also brings the need to develop new skills for this contact (Qvist-Sorensen 2020). In this way, companies that are serving their proposals with the support of AI need a qualified workforce that has the technical knowledge to use AI in back-office activities and that can train their customers so that this interaction can take place. with technology occurs in the best possible way.

In the technology dimension, the challenges are related to the need for the base technology implemented correctly (Heinis et al. 2018), where companies generally do not have appropriate processes to develop and test new offers for customers (Björkdahl 2020) as, for example, sensors and embedded systems with communication capabilities adapted to products so that AI can deliver the expected results (Heinis et al. 2018). In the front office, the challenges present themselves in the need for simple and intuitive platforms for users to use (Cenamor et al. 2017), and in the connection capacity, where, in the case of smart products, those that do not have the functionality of connection cannot offer, for example, dynamic functions and real-time management, limiting the benefits in creating value for customers (Lenka et al. 2017). In this sense, the high investment in technology appears as a risk factor for this type of implementation (Jantunen et al. 2018), where, especially in the front office, it is necessary to apply an interactive AI, which can demand many resources. Thus, technological challenges are related to the processes and technologies that support AI and allow it to play its roles, such as IoT and cloud computing.

In the organization dimension, the challenge pointed out lies in the fact that when companies go to servitized solutions with AI, this strongly impacts the company's strategy, due to the characteristics of this technology (Björkdahl 2020),

and it is necessary to have a culture focused on innovation, where the organization needs to provide the necessary support for change, both for internal processes and for new ways of interacting with customers (Qvist-Sorensen 2020). Regarding the environment dimension, both in the back and front-office, challenges arise when companies start to implement new technologies, such as AI and need to deal with the uncertainties of the external environment, as they are starting to propose new technologies (Björkdahl 2020), making them need to collaborate closely with other companies that will sometimes provide the technology or support its implementation (Lerch and Gotsch 2015; Enrique et al. 2018), for this change to take place more securely. and assertive. For example, ABB has embarked on a strategic collaboration with IBM, where it will leverage Watson's AI to find defects through real-time production images, captured by ABB-powered equipment and analyzed using IBM Watson IoT for Manufacturing. In this way, it will be possible to reduce the uncertainties and risks related to the implementation, as it starts working with a company that already dominates the technology.

5. Conclusion

In recent years, the literature has devoted special attention to the process of digital transformation of industries into companies, especially within the context of Industry 4.0, with technologies that support this process, such as AI. In the same way, these technologies make it possible to offer services, making product companies look for these opportunities, add services to their proposals with the offer of PSS, and obtain a competitive advantage. In this context, the objective of the study was to identify in the literature, how AI can support the servitization process of product companies

For this, an RSL was carried out seeking studies that addressed servitization and AI simultaneously, based on the PRISMA method by Moher et al. (2015), followed by the analysis and discussion of the results, addressing the most relevant points of the research. RSL pointed out research opportunities in the area of AI still little explored in the literature with a low number of studies that address servitization in product companies with the support of AI, with only 12 studies identified, and with the first study only from the year 2015. In these studies, the Journals with the largest number of publications brought articles that address AI as a technology that facilitates servitization and supports the general innovation activity of companies.

The results showed that AI can bring countless benefits to manufacturing companies, where they have the chance to transform big data into useful information, both in solutions for their internal processes and customer contact, enabling new business models that would be very difficult or even impossible to implement without the technology. However, it became evident that AI is still being applied more in back-office solutions, in support processes, especially in predictive maintenance, being in few solutions with direct contact with users. This shows a little-explored potential about this technology, since there are several possibilities of applications in the front office, due to its ability to interact, analyze, learn and adapt (Huang and Rust 2020).

The main challenges identified for implementing AI relate to the need for foundational technologies such as IoT and cloud computing so that companies can capture the full potential of AI. Also, due to the new forms of interaction made possible by technology, it becomes a challenge to predict how this interaction is perceived, both by the organization and by the customers, in the back and front-office activities, which is related to the newest technology.

It was possible to identify that the literature works on the functionality offered in digital transformation, but does not explore the how, and this leaves a gap in the literature. For example, studies such as the one by Zheng et al. (2018) address intelligent PSS but do not mention artificial intelligence in systems, as technology is largely in this type of solution and AI is assumed to be behind this solution but does not explain the technology and how it should be done, leaving, from the point of view of the implementation of servitization solutions, great doubts because the contribution to digital transformation is clear, but not how the path for specific technologies such as AI is. In this way, the study points out that even with a vast literature on digital servitization, it still generically presents itself about the technological aspect, which needs to be addressed in more depth, since it is not a simple aspect in terms of implementation. Even with its limitations, mainly related to the nature of RSL, where eligibility requirements were selected such as language, research areas and types of documents, which may have left out studies that could complement the research, this review brought results that can contribute both to theory, as with practice.

As a theoretical contribution, this study compiles the findings in the literature on the application of AI in the servitization of product companies, with its applications in the back and front-office. It also describes the impact that the implementation of AI solutions can have on traditional business models, as well as the challenges that companies may face in this process. In addition, the study brings new cases and applications, pointing out research gaps, which can guide future studies.

The study also brings practical contributions, since the results can be used by companies and their managers to guide the implementation of AI in the servitization of their proposals because, in addition to bringing examples of applications in product companies, it describes the application, as well as the challenges according to the socio-technical factors that accompany the application in the back and front office and how this impacts their business models, which can make this movement of servitization with AI safer.

Considering that most of the identified literature approaches AI generically, without describing the application and the type of AI that is behind the solution, an in-depth analysis of how product companies are implementing it is suggested for future studies. these solutions, what types of AI are implemented, and what is the motivation behind the use of this specific technology. Also, a case study is interesting to know fact in which solutions of product companies AI is present because in cases such as intelligent products, this study showed that it is not clear in the literature which technology is at stake. brings this intelligence.

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Biographies

Jassen Rodrigues da Silva, Eng. is a master's degree candidate at the Department of Industrial Engineering of the Federal University of Rio Grande do Sul – Brazil. He is member of the Organizational Engineering Group (NEO – Núcleo de Engenharia Organizacional) at UFRGS. His research is concerned with the use of artificial intelligence in company servitization.

Alejandro Germán Frank, Ph.D. is an Associate Professor of Industrial Organization at the Department of Industrial Engineering of the Federal University of Rio Grande do Sul (UFRGS) – Brazil and a Research Affiliate at the Industrial Performance Center of the Massachusetts Institute of Technology (USA). At UFRGS, he is also the director of the Organizational Engineering Group (NEO – Núcleo de Engenharia Organizacional). He has been a visiting scholar at the Massachusetts Institute of Technology (USA), and Politecnico di Milano (Italy). His research is devoted to the interface between operations and technology management, with emphasis on digital transformation, Servitization, Industry 4.0, and new business models in manufacturing firms.

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